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The purpose of this final report is to document the ADST II effort which supported the Global Positioning System Distributed Interactive Simulation (GPS DIS) experiment. This report includes a full description of the experiment and its conditions. A lessons learned section is also included to improve the efficiency and performance of, and reduce the cost of, future experiments. It is also the intent of this report that the information contained be used to reduce the time required to prepare for and perform any future add-on effort to the GPS DIS experiment.

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GLOBAL POSITIONING SYSTEM DISTRIBUTED INTERACTIVE SIMULATION (GPS DIS) EXPERIMENT

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1.1 Purpose

The purpose of this final report is to document the ADST II effort which supported the Global Positioning System Distributed Interactive Simulation (GPS DIS) experiment. This report includes a full description of the experiment and its conditions. A lessons learned section is also included to improve the efficiency and performance of, and reduce the cost of, future experiments. It is also the intent of this report that the information contained be used to reduce the time required to prepare for and perform any future add-on effort to the GPS DIS experiment.

1.2 Experiment Description

The Command and Control Systems Integration Directorate (C2SID) of the US Army Communications and Electronics Command (CECOM) has been designated as the Navigation Warfare (NAVWAR) Army program coordinator. As such, they have been tasked to study the issues and concerns unique to the Army with regard to the impact of GPS denial (due to jamming) on Army military operations and to recommend effective solutions. The NAVWAR program is directed and sponsored by the Global Positioning System (GPS) Joint Program Office (JPO) and Army Project Manager for GPS (PM GPS). The unique GPS issues the Army encounters include:

- A very large number of different platforms involved.
- A large variety of missions supported.
- GPS signal acquisition must be accomplished in an adverse Electromagnetic Interference/ Electromagnetic Countermeasure (EMI/EMC) environment.
- Operation at close proximity to jammers.
- Jammers encountered by the Army platforms are effective and cheaper to deploy than those required to jam other service's platforms

The classified GPS DIS experiment was in support of CECOM's study.

GPS is a well known tool that assists both the military and commercial community in navigation world wide. The purpose of the GPS DIS experiment was to use man-in-the loop simulators and synthetic simulated forces to gather data that will be used to assess the effects of simulated electronic interference signals (due to jamming) on the operational use of the GPS in various tactical situations. This data will be used to assess the impact of the partial or total loss of GPS to a ground maneuver combat element operating as a Company element of a Battalion Level Combined Arms Task Force with AH-64 Apache helicopter close air support during tactical operations. Analysis of the data will assess the impact of the use of GPS in supporting one or more elements attempting to conduct rearming and resupply operations in relatively featureless terrain under foggy conditions.

The featureless terrain and fog also prevented vehicle crews from relying on manual position determination techniques such as intersection and resection.

In addition, the data will measure the effectiveness of jamming GPS equipped units and the impact this interference has on units' Command and Control, Situation Awareness, Maneuver, Battle Tempo and overall mission effectiveness at the Brigade and Below element level. It will also review the effectiveness of GPS in allowing the maneuver element commander to mass his forces at a critical time and place on the battlefield to achieve tactical victory over an opposing force. The experiment will help to gain insights into the vulnerabilities of GPS due to various electromagnetic interference (EMI) and electronic countermeasure (ECM) effects. These insights will be used to revise the doctrine and training manuals and influence future hardware upgrades to GPS. Primary objectives of this experiment were:

1) To assess the effect of partial/total loss of GPS capability on various Army tactical platforms and their operational performance within the maneuver element due to electronic jamming.

2) To assess the effect of partial/total loss of GPS capability on Situational Awareness and Command and Control of Battalion and Below elements due to electronic jamming.

3) To assess implications of GPS countermeasures across the domains of Doctrine, Training, Leaders, Organization, Material, and Soldiers (DTLOMS).

The experiment utilized M1A2 variant tank simulators (configured as notional, future digitized variants), a resupply vehicle simulator (Dial-A-Tank), role players, and Modular Semi-Automated Forces (ModSAF) at the Mounted Warfare Test Bed (MWTB) at Ft. Knox, Kentucky. These simulation assets were linked to AH-64A Apache rotary wing simulators at the Aviation Test Bed (AVTB) at Ft. Rucker, Alabama via a Long Haul Network (LHN) (Figure 1-1). Existing Appliqué Command and Control (C2) systems and radio model systems were utilized. The radio models utilized were the Single Channel Ground and Airborne Radio System (SINCGARS) Radio Emulator (SRE), the ASTi Radio, and the Tactical Internet Model (TIM). In addition, the Government supplied an extension to the TIM - the "Situational Awareness (SA) Server" - as well as a new variant of the Precision Lightweight GPS Receiver (PLGR) model which simulated the effects of GPS denial. This variant is known as the CECOM Integrated GPS Navigational Model (CIGNM). The parameters of the CIGNM jamming software are classified, therefore the entire experiment and its environment was classified at the SECRET level.

The detailed description of the man-in-the-loop experiment is provided in paragraph 4. The GPS DIS experiment utilized the following equipment, which is discussed more fully in paragraph 3:

- 4 manned M1A2 simulators with TIM and Appliqué
- 2 Manned Apache Simulators with Appliqué
- 1 Reconfigurable manned simulator as a resupply vehicle with Appliqué

- 1 Manned Desktop Appliqué for the S3
- Virtual Red forces (OPFOR) provided by ModSAF
- Virtual Blue forces (BLUFOR) provided by ModSAF

There were 2 types of Man-in-the-Loop Experiments.

- M1A2 Rendezvous, Cross Country March Mission Experiment.
- Apache Deep Attack Mission Experiment.

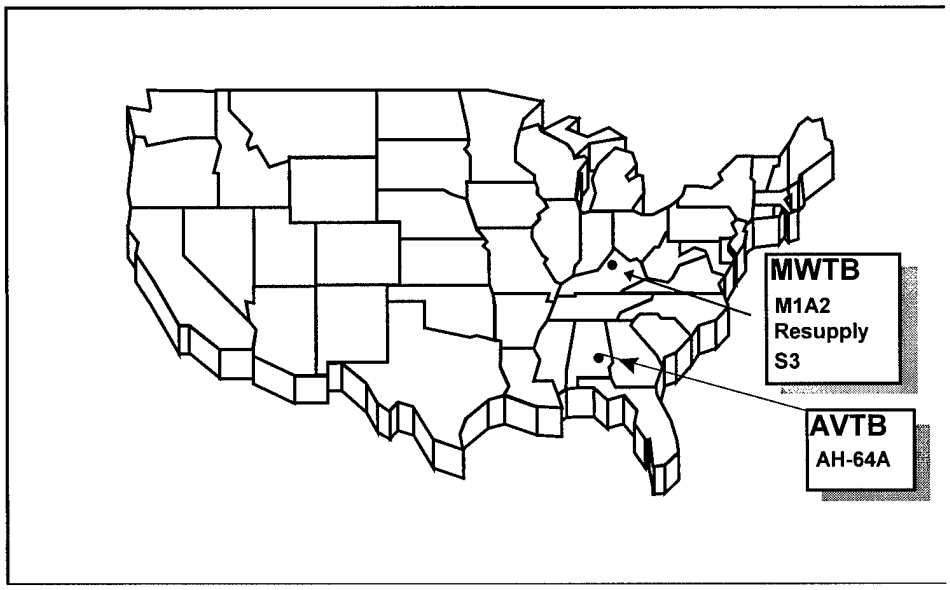

Figure 1-1 GPS DIS Long Haul Network Sites

The four manned M1A2 simulators were configured as a Platoon within a Blue Armor Company. The remainder of the Company included two additional tank platoons of Blue ModSAF, and a Company Commander and Executive Officer role-playing from a ModSAF workstation. The Blue Force (BLUFOR) conducted tactical operations against an appropriate doctrinally approved and depicted Opposing Force (OPFOR) ModSAF threat.

Data collection and scenario briefings were held at the beginning and end of each day, and scenario briefings were held between runs. These briefings were supported by Video TeleConference (VTC). The VTC equipment and service were provided by the CECOM Technology Support Cell.

The experiment included two formal meetings (Kick-Off meeting and VIP Day) and one informal meeting via telephone (Test Readiness Review (TRR)). The experiment also included local integration periods for integration of local assets and GFE/GFI software and hardware as well as three long haul integration tests between the two sites. After the third

long haul test was completed, Fort Knox and Ft. Rucker conducted troop training and a Pilot Test prior to the actual experiment.

The TRR was held via telephone communications on Sunday November 2. At the TRR, it was decided the system was ready to start the experiment, which began on November 3, 1997. The actual experiment period lasted three weeks during which 48 different iterations plus excursion runs were executed using six different overlays in both day and night exercises. The experiment contract called for two CDRL items, the collected & reduced data (AB01) and this Final Report (AB02). The AB01 reduced data is delivered separate from this report. The Battle Lab Experiment Plan is included as Appendix C.

1.2.1 Assumptions

The following assumptions were used in the planning of this effort:

a) The Government was to be responsible for the overall development, integration, test, and installation of the new PLGR (CIGNM) and TIM SA Server simulations. The ADST II contractor was to provide technician support to the Government for these systems.

b) The Government was to be responsible for supplying the primary PLGR (CIGNM) and TIM support at the MWTB and AVTB for this effort.

c) The existing ADST II National Training Center (NTC) terrain database was to be used in this effort.

1.2.2 Government Furnished Equipment/Government Furnished Information (GFE/GFI)

The following GFE/GFI was not part of the ADST II property inventory or was data/information not contained in the ADST II Master Library. This following GFP/GFI was provided by the Government to support the execution of this experiment.

a) SA Server model for TIM and associated hardware.

b) New PLGR variant model for Appliqués (CIGNM) and associated hardware.

1.3 Technical Overview

The technical approach to the GPS DIS Experiment was to utilize and integrate existing ADST II MWTB and AVTB simulators and associated supporting equipment, Appliqués, ModSAF (version 2.1) and other on-hand site equipment (i.e. computers, Dial-A-Tank, etc.) to accomplish the objectives of the experiment. The effort also involved addition of the new SA Server and the CIGNM, as well as modification of the Multi-Purpose Digital Display (MPDD) software in the AH-64A Apache manned simulators at the AVTB (this modification is described more fully in paragraph 3.2.12 below).

The voice radio communications models selected for the experiment were SINCGARS Radio Emulators (SREs) running on SGIs at the MWTB and ASTi radios at Ft. Rucker. These two

systems were known to be compatible however, it was necessary to turn the ModSAF radios off as the Signal Protocol Data Units (PDUs) that the ModSAF entities generate presented too much load to the LAN.

This was not a problem since the ModSAF radios were not used in the experiment. All manned simulators and role players used the same frequency except for the S3. The TIM and the SA server were integrated with the MWTB & AVTB manned simulators and at the S3 station to provide simulated data communications for the Appliqué systems. Format modifications to the TIM Signal PDUs were necessary to keep them from interfering with the SREs.

There was a visual database correlation discrepancy between the manned simulators and the rest of the system at the MWTB requiring a position translation computer.

2. Applicable Documents

2.1 Government

ADST II Work Statement for Global Positioning System Distributed Interactive Simulation (GPS DIS), August 22, 1997, AMSTI-97-WO70, Version 1.0

Battle Lab Experiment Plan (BLEP) for Global Positioning System Distributed Interactive Simulation (GPS DIS), ATZK-MW, Fort Knox, KY, September 12, 1997

Battle Lab Experiment Plan (BLEP) for Global Positioning System Distributed Interactive Simulation (GPS DIS), ATZK-MW, Fort Knox, KY, September 22, 1997

2.2 Non-Government

None

3. System Description

3.1 System Configuration and Layout

The MWTB at Fort Knox, KY and the AVTB at Ft. Rucker, AL both posses a variety of vehicle simulators, networks, Semi-Automated Forces (SAF) capabilities, displays for monitoring the battlefield, utilities to facilitate exercises, automated data collection capabilities, data reduction and analysis subsystems, and other simulation equipment. The layout of the MWTB simulation components used for GPS DIS are depicted in Figure 1-2. The components used in the experiment at the sites were interconnected via Ethernet LANs using Distributed Interactive Simulation (DIS) 2.03 protocol at the MWTB and a mix of DIS 2.03 and Simulation Network (SIMNET) protocols at the AVTB. The sites were interconnected via the Defense Simulation Internet (DSI) Long Haul Network provided by

the Defense Information Systems Agency (DISA). The system block diagram is shown in Figure 1-3.

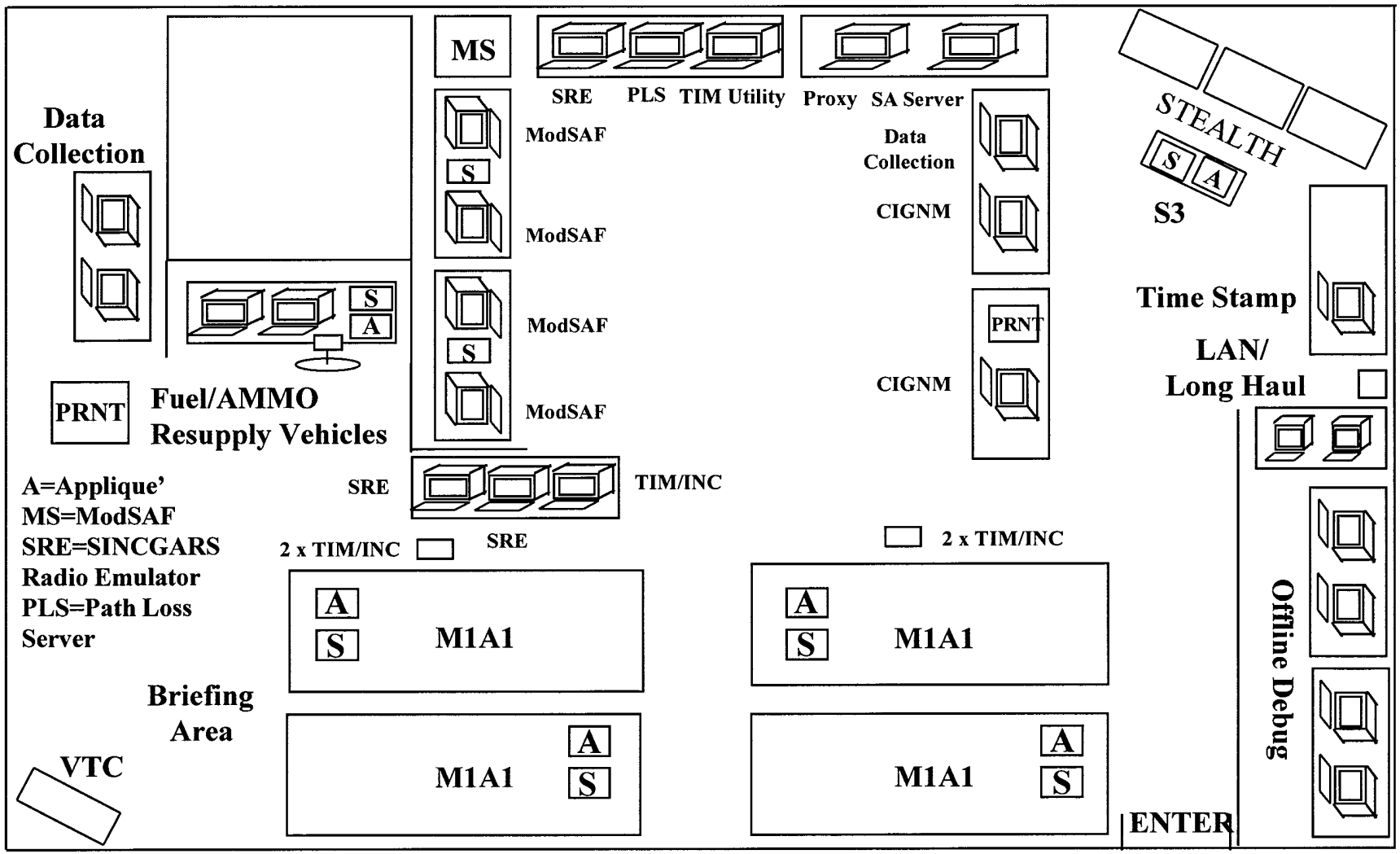

Figure 1-2 GPS DIS Asset Layout at MWTB

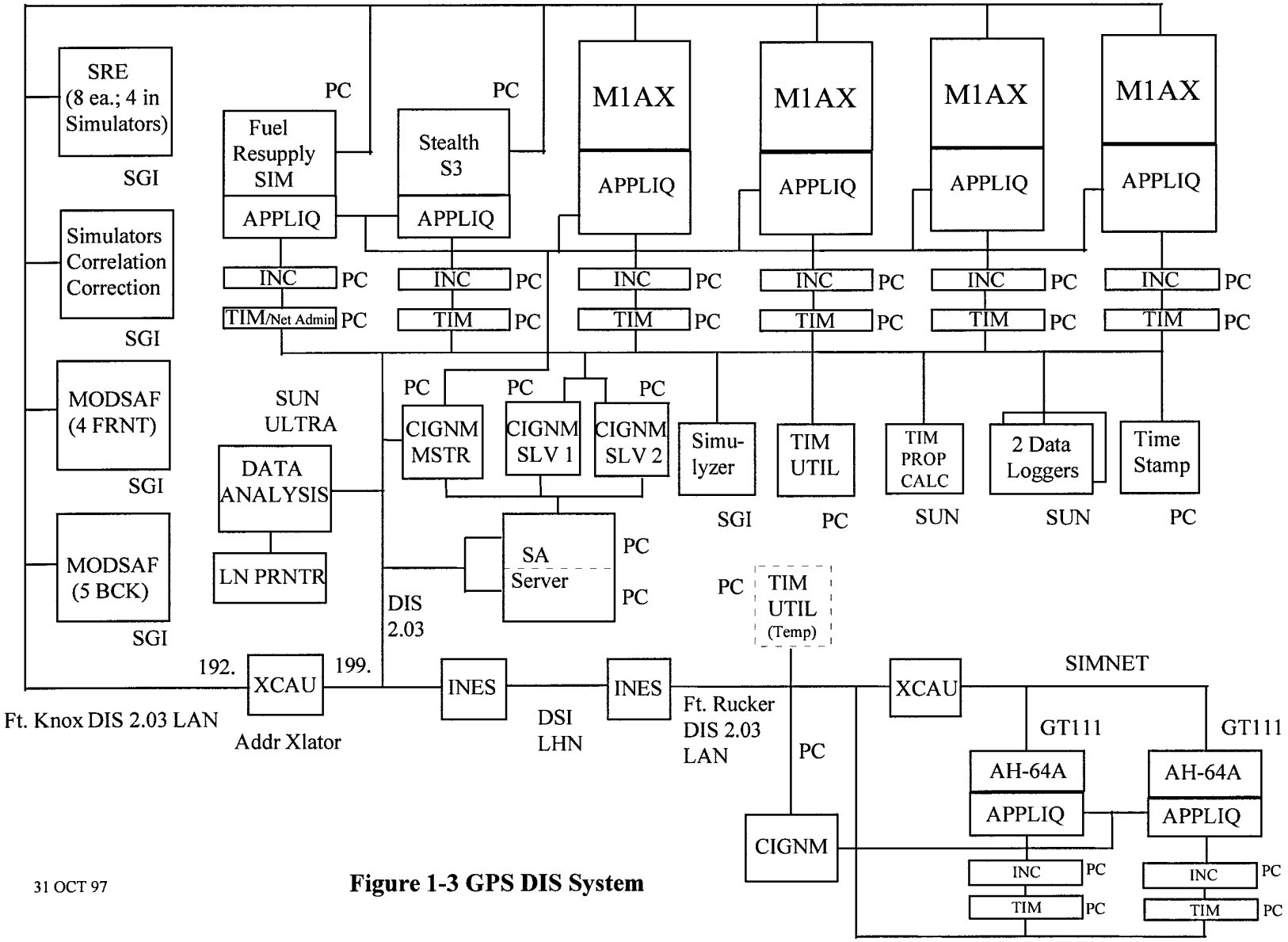

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Figure 1-3 GPS DIS System

3.2 Description of System Components

This section discusses the description, functionality and operation of the system components, which includes the GFE models and their integration with the hardware at both the MWTB and AVTB.

3.2.1 Appliqué

The Appliqués were existing ADST II site assets which ran Appliqué software version 1.01a. The Appliqué computer display was mounted on a shelf to the left of the Tank Commander in the M1A2 manned simulators at the MWTB and placed on a shelf to the left of the Gunner in the Apache Rotary Wing Aircraft (RWA) simulators at the AVTB. A 17 inch monitor was attached to the Appliqués in the RWAs to provide the Gunner a more convenient view. When not being jammed, the Appliqué provides a color map showing accurate, timely platoon member locations, threat warnings, and map overlays. Appliqué also allows sending and receiving Intelligence Reports, Contact Reports, and Fragmentary Orders.

3.2.2 CECOM Integrated GPS Navigational Model (CIGNM)

Normally, the Appliqué gets its position data from a Precision Lightweight GPS Receiver (PLGR), but in the GPS DIS experiment, the Appliqué received its position data from a new PLGR model known as the "CECOM Integrated GPS Navigation Model" (CIGNM). The CIGNM simulated the effects of GPS jamming on the simulated GPS receivers. The following is an overview of the operation of the CIGNM and its operational interface with the SA Server.

a) CIGNM receives Entity State PDUs (ESPDUs) for every BLUFOR entity in the exercise.

b) The navigation information in these ESPDUs is "perturbed" by CIGNM consistent with the navigation model for that entity's model.

c) CIGNM then sends this data to one of two places as follows:

1) If the entity is a Man-In-Loop (MIL) role player, the perturbed navigation information is sent via serial data lines to the Appliqué in the tank, truck, or RWA simulator. CIGNM formats this data to look like data coming from a GPS receiver. In this role the CIGNM is simulating the GPS receiver that would be on-board the entity which hosts the Appliqué. After Appliqué receives this own-ship GPS data, it then sends Position Reports in Variable Message Format (VMF) via the TIM/INC (simulating the RF-connectivity of the Tactical Internet) over the DIS LAN so that all other Appliqués know the location of that MIL entity.

2) If the entity is a Blue Computer Generated Force entity, the data is passed via a dedicated ethernet data link from the CIGNM to the SA-Server. The SA-Server then takes this data and reformats it into VMF format. In this role, the SA Server is simulating the Appliqués and communications links for all the non-MIL (ModSAF) entities. This VMF format data (in a TIM Signal PDU) is sent out over the DIS LAN in order to distribute the SA-picture to all Appliqués on the net.

3.2.3 Data Communications: Tactical Internet Model and Situational Awareness Server

The Tactical Internet Model (TIM) was used for data communications (Appliqué-to-Appliqué) in the GPS DIS Experiment. The TIM was provided by MITRE Corporation and the Communications and Electronics Command (CECOM). The TIM was developed by MITRE for CECOM to both support the training of the Task Force XXI Experimental Force (EXFOR) at Fort Hood, Texas and to provide for the analysis of various concepts for the Tactical Internet. The TIM provides realistic simulations of voice and data communications over the Single Channel Ground and Airborne Radio System (SINCGARS) System Improvement Program (SIP) and the Enhanced Position Location Reporting System (EPLRS) radios. It also includes a simulation of the Internet Controller (INC) which serves as a router for digital messages through the Tactical Internet. The TIM simulates both radio propagation communication effects and Tactical Internet message routing delays.

The TIM is comprised of 4 basic components: the TIM PC which hosts the core of the software model; the INC PC which hosts the INC portion of the model and interfaces with the Appliqué; the Propagation Server which performs Terrain Integrated Rough Earth Model (TIREM) propagation loss calculations for all TIMs on the network; and the TIM Utilities system which provides automated initialization and maintenance operations for the TIMs. For GPS DIS, the same PC hosted both the TIM Propagation Server and Utilities operations.

As an extension to the TIM, Mitre developed a modeling and simulation tool referred to as the "SA –Server." The SA Server operates in conjunction with the TIM and CIGNM to provide perturbed ModSAF entity position data (in VMF format) to all the Appliqués in the system. The SA Server acts as an Appliqué for each of the ModSAF entities, sending out SA messages (Position Reports) for each entity (based on their CIGNM-provided GPS location). In addition, the SA Server simulates the communication effects on these messages in the same manner as the TIM. The result is that SA data from ModSAF entites is displayed on the appropriate Appliqué screens as if there was an Appliqué, TIM, and PLGR for each ModSAF entity. The data messages are delayed and corrupted in the same way as those being sent through the individual TIM seats.

For the GPS DIS experiment, format modifications to the TIM Signal PDUs were necessary to keep them from interfering with the SREs.

3.2.4 Dial-A-Tank Manned Simulator (Resupply Vehicle)

The Dial-A-Tank Reconfigurable Simulator was used at the MWTB for the fuel and ammunition resupply role player. The Dial-A-Tank simulator uses three SGI computers, each uses its own database. The memory in the three Dial-A-Tank computers was not large enough to contain the entire NTC data base, so one of four different areas of the database were loaded before each exercise to support that exercise. This simulator utilizes a steering wheel apparatus to steer the role vehicle. An Appliqué was provided for use by the role player.

3.2.5 M1A2 and AH-64A RWA Manned Simulators

Four M1A2 variant simulators were used at the MWTB for GPS DIS. The simulators represented a Tank Platoon as part of an Armor Company. Each simulator had an Appliqué Command and Control Tactical Display (C2TD) installed, which were Compaq Elite Laptop Computers running Appliqué software version 1.01a. In order that the tank crews use only the Appliqué to determine their position, the IVIS and CITV instrument panels were covered to preclude their use during the experiment.

Two RWA manned simulators were used at the AVTB configured as AH-64A helicopters. These simulators represented an Attack Helicopter Section employed in support of an Armor Company on selected missions. Each RWA had an Appliqué C2TD installed. To insure that RWA crews used only Appliqué to determine positions, the RWA's native MPDDs were filtered to prevent portrayal of MPDD location information during the experiment.

3.2.6 Voice Radio Communications: SRE & ASTi

The SINCGARS Radio Emulator (SRE) is a high-fidelity, DIS-compliant radio model of the SINCGARS Improved Communications Security (ICOM) radio. It simulates radio functionality and the realistic transmission of voice and data communications over the DIS network. The SRE uses the Terrain Integrated Rough Earth Model (TIREM) to calculate the terrain propagation and degradation effects on both voice and data transmissions. The initial SRE was developed under ADST I, and included the CECOM SINCGARS Radio Model (SRM) software core. The SRE has been updated and enhanced under ADST II, and now incorporates the Close Combat Tactical Trainer's (CCTT's) SRM core.

The ASTi radio model is a slightly lower fidelity, DIS-compliant radio model that can simulate various radios, including UHF, VHF, and SINCGARS radios. The ASTi model uses a curvature of the earth propagation model to calculate communication degradation effects.

SREs were used at the MWTB for the tanks, role players and ModSAF operators and SRE-compatible ASTi radios were used at Ft. Rucker in the RWAs to simulate voice radio communications. All entities except for the S3 operated on the same frequency. During the experiment, the SREs began to suddenly go down for no apparent reason, investigation revealed that the ModSAF entities were emitting Signal PDUs for each entity which created too much radio traffic for the SREs to operate properly. Turning the ModSAF radios off (no reason for them to be on in this experiment) reduced the radio traffic and resolved this problem.

An additional problem for the SREs was due to the format of the TIM Signal PDUs. The original format of these PDUs was inconsistent with the Signal PDUs put out by the SREs. The result was that the TIM PDUs confused and froze the SREs. This problem was fixed by changing the format of the TIM Signal PDUs.

3.2.7 ModSAF Operations

GPS DIS used ModSAF version 2.1 for BLUFOR round-out and OPFOR forces. BLUFOR ModSAF provided the additional platoons required for the Armor Company, as well as the

Company Commander and Executive Officer, and a Scout Section. Four ModSAF "Frontends" and five "Backends" were used for the experiment. During the experiment, the AH64A pilots noticed that their "Probability of Kill" (PK) seemed low. Investigation found that the ModSAF PK was set to 10 % which is unrealistically low. The PK was left at 10 % because the Experiment Director said that changing it would make the collected data inconsistent.

3.2.8 Data Logger

The Data Logger is an ADST II asset that captures the network traffic and places the data packets on a disk or tape file.

The Data Logger performs the following functions:

a. Packet Recording - Receives packets from the DIS network, time stamps and then writes to a disk or tape.
b. Packet Playback - Packets from a recorded exercise can be transmitted in real time or faster than real time. The Data Logger can also suspend playback (freeze time) and skip backward or forward to a designated point in time. The logger can be controlled directly from the keyboard or remotely from the Plan View Display (PVD). Playback is visible to any device on the network (PVD, Stealth Vehicle, a vehicle simulator, etc.).
c. Copying or Converting - Files are copied to another file, which can be on the same or a different medium; and files from the older version of the Data Logger can be converted to a format compatible with the current version of the Data Logger.

For GPS DIS, two data loggers were employed at the MWTB to capture the exercise providing a redundant data logging capability. The two data loggers were placed on the DIS net to capture all DIS PDUs for later analysis.

3.2.9 Time Stamper

The MWTB provided a Time Stamper which consisted of a time code generator. This time code generator produced time data in days, hours, minutes, and seconds format and ran on an IBM-compatible Personal Computer (PC). The PC was programmed to generate a Time PDU which was issued onto the DIS LAN each second. This provided the "real world" clock time on the logged data to assist in subsequent analyses.

3.2.10 Stealth System

An ADST II Level II Stealth was used at the MWTB to provide the S3 an "out-the-window" view into the virtual battlefield. The Level II Stealth uses an Onyx Image Generator to provide the same high level of visual fidelity as seen in the M1A2 simulators.

The Stealth is a visual display platform that consists of a Plan View Display (PVD), various input devices, and three video displays that provide the operator with a panoramic 3D view of the battlefield. The Stealth permits the controller to fly around the virtual battlefield and view the simulation without interfering with the action. The features of the Stealth allow the observer to survey the virtual battlefield from a variety of different perspectives, including:

a. Tethered View - Allows the user to attach unnoticed to any vehicle on the virtual battlefield. The Executive Officer was always tethered to his ModSAF vehicle.

b. Mimic View - Places the user in any vehicle on the virtual battlefield and provides the same view as the vehicle commander.

c. Orbit View - Allows the operator to remain attached to any vehicle on the virtual battlefield and to rotate 360° about that vehicle, while still maintaining the vehicle as a center point of view.

d. Free Fly Mode - Permits independent 3-D movement anywhere in the virtual battlefield.

3.2.11 DIS LAN Network Configuration and Long Haul Network

A standard DIS LAN configuration was used with Ten Base T/AUI cable. Standard Internet Protocol (IP) was used, and the IP addresses for the system components are given in Table 3-1. The Long Haul Network was provided by the Defense Information Systems Agency (DISA) and Houston Associates, with the MWTB & AVTB connections funded by STRICOM. Test of the long haul was split into three efforts to incrementally test the system at three levels of ascending complexity. The first test verified:

a) Long haul connectivity,

b) Model identification (entity type),

c) Visual database entity correlation (xyz location),

d) Radio communication.

The second long haul verified the operation of new contractor software (GPS CIGNM and SA Server) and software modifications (MPDD), and the third was for Pilot Test and network loading tests. The Simulyzer and "Network Sniffer" tools were used to monitor network communications.

ITEM	Ft. Rucker COMPUTER	IP ADDRESS	PORT No.
1	Classified Router	199.55.227.1	3000
2	SGI In Computer Room (Troubleshoot)	199.55.227.3	3000
3	SGI (Appliqué Troubleshoot)	199.55.227.4	3000
4	MPDD at "83' Simulator	199.55.227.5	3000
5	MPDD at "86" Simulator	199.55.227.6	3000
6	ASTi at Battlemaster Station	199.55.227.7	3000
7	Meta VR Stealth at Battlemaster Station	199.55.227.8	3001
8	ModSAF (Pentium) at Battlemaster Station	199.55.227.9	3000
9	ASTi at "83" Simulator	199.55.227.10	3000
10	SAF Simulator #1 (Developer)	199.55.227.11	3000
11	SAF Simulator #2	199.55.227.12	3000
12	CIGNM - 4	199.55.227.13	3000
13	TIM Maintenance	199.55.227.16	3000
14	TIM at "83" Simulator	199.55.227.17	3000
15	INC at "83" Simulator	199.55.227.18	3000
16	TIM at "86" Simulator	199.55.227.19	3000
17	INC at "86" Simulator	199.55.227.20	3000
18	DIS XCIAU	199.55.227.25	3000
	Ft. Knox		
1	Classified Router	199.55.242.1	3000
2	CIGNM Master	199.55.242.130	3000
3	CIGNM Slave 1	199.55.242.131	3000
4	CIGNM Slave 2	19955.242.132	3000
5	TIM 1a	199.55.242.242	3000
6	TIM 2a	199.55.242.241	3000
7	TIM 3a	199.55.242.244	3000
8	TIM 4a	199.55.242.245	3000
9	TIM 5a	199.55.242.246	3000
10	TIM 6a	199.55.242.247	3000
11	INC 1a	199.55.242.191	3000
12	INC 2a	19955.242.192	3000
13	INC 3a	199.55.242.193	3000
14	INC 4a	199.55.242.194	3000
15	INC 5a	199.55.242.195	3000
16	INC 6a	199.55.242.196	3000
13	SA Server (td410a)	199.55.242.136	3000
17	Proxy (td410b)	199.55.242.137	3000
18	TIM Maintenance	199.55.242.249	3000
19	TIM Server 1	199.55.242.47	3000
20	XCIAU Port 1	199.55.242.100	3000

Table 3-1 GPS DIS System Component IP Addresses

	Ft. Knox (Continued)		
21	Simulyzer	199.55.242.3	3000
22	Time Stamper	199.55.242.240	3000
23	Data Logger	199.55.242.139	3000
24	Data Collection and Analysis	199.55.242.51	3000
25	Manned Simulator 2G (GDLS Card Cage)	192.67.227.38	3050
26	Manned Simulator 2H (GDLS Card Cage)	192.67.227.36	3050
27	Manned Simulator 3G (GDLS Card Cage)	192.67.227.37	3050
28	Manned Simulator 2H (GDLS Card Cage)	192.67.227.35	3050
29	Manned Simulator 2H ONYX	192.67.227.28	3000
30	Manned Simulator 2G ONYX	192.67.227.29	3000
31	Manned Simulator 3H ONYX	192.67.227.27	3000
32	Manned Simulator 3G ONYX	192.67.227.30	3000
33	Manned Simulator SINCGARS 2G	192.67.227.103	3000
34	Manned Simulator SINCGARS 2H	192.67.227.104	3000
35	Manned Simulator SINCGARS 3G	192.67.227.107	3000
36	Manned Simulator SINCGARS 3H	192.67.227.159	3000
37	SINCGARS S3	192.67.227.170	3000
38	Dial-A-Tank SINCGARS	192.67.227.86	3000
39	Battlemaster SINCGARS 1	192.67.227.77	3000
40	Battlemaster SINCGARS 2	192.67.227.78	3000
41	Stealth	192.67.227.32	3000
42	PVD	192.67.227.39	3000
43	Dial-A-Tank	192.67.227.150	3000
44	Dial-A-Tank	192.67.227.151	3000
45	Dial-A-Tank	192.67.227.152	3000
46	Manned Simulator Visual Database Correlator	192.67.227.40	3000/3050
47	ModSAF 1	192.67.227.82	3000
48	ModSAF 2	192.67.227.63	3000
49	ModSAF 3	192.67.227.84	3000
50	ModSAF 4	192.67.227.220	3000
51	ModSAF 5	192.67.227.101	3000
52	ModSAF 6	192.67.227.237	3000
53	ModSAF 7	192.67.227.238	3000
54	ModSAF 8	192.67.227.44	3000
55	ModSAF 9	192.67.227.45	3000
57	XCIAU Port 2	192.67.227.212	3000

Table 3-1 (cont'd) GPS DIS System Component IP Addresses

3.2.12 Multi-Purpose Digital Display Modification

The Apache AH-64A Multi-Purpose Digital Display (MPDD) displays objects in icon form (with their locations) that are both within and beyond the visual limitations of the simulator out-the-window visual displays. In order that the MPDD-equipped AH-64A role players not be able to assess or determine their own-ship situation awareness through any means other than that derived from the CIGNM, it was necessary to modify the MPDD and the CIGNM software. The CIGNM was modified to send the "perturbed" position ESPDUs for the RWAs out on the DIS LAN with a different exercise number than that which was being used for the actual exercise (exercise number + 1). The MPDD was modified by TASC Inc. to receive its ESPDUs under this exercise number + 1, and also to suppress the position data for all entities shown on the MPDD.

3.3 Experiment Security

The GPS DIS experiment was classified SECRET because the CIGNM position jamming parameters were classified. The manned simulators and all experiment equipment was contained in access controlled areas requiring all personnel to possess SECRET Clearances with Visit Requests on file with the security department at each site. The sites were inspected by the Defense Investigative Service (DIS) prior to classified operations. The local site networks and long haul networks at both sites were isolated from all non-experiment LANs and equipment, and operated in a classified mode. All personnel were required to sign in and out of the closed areas each day, and a log of operation was kept at each computer.

3.4 Visual Databases

The existing ADST II National Training Center (NTC) terrain database was used to support the experiment. The database was 50 Km by 50 Km with predominately featureless areas chosen for the exercises played in foggy weather conditions. The memory in the three Dial-A-Tank computers was not large enough to contain the entire NTC data base, so one of four different areas of the database were loaded before each exercise to support that exercise. Also, the manned simulators' visual databases did not correlate with the databases in the rest of the simulation systems, which necessitated the use of a "position correcting" computer. This computer acted as a bridge between hardware on two networks. The simulators and Stealth were on one side and SAF and Dial A Tank were on the other side. The computer would make minor corrections to allow systems on both sides to have accurate correlation.

3.5 Scenario Development

A series of six test scenarios were developed by SES Inc. to support GPS DIS. These scenarios depicted an Armor Company conducting Movement to Contact, Deliberate Attack, and Defense operations. The scenarios included Operations Orders (OPORDs), Fragmentary

Orders (FRAGOs) and overlays to support the missions. The MWTB has maintained copies of the tactical overlays. SES Inc. maintains the complete scenario package.

3.5.1 Task Organization and Corresponding Bumper Numbers

The task organization and corresponding bumper numbers are shown in Table 3-2.

TM D/3-66 AR BN (1-22AS)			TM C/3-66 AR BN (1-22AS)		
BUMPER #	**ROLE**	**NOTES**	**BUMPER #**	**ROLE**	**NOTES**
Company Elements			Company Elements		
366D65	XO-D66		366C65	XO-C65	
366D65	CDR-D66	Role-Played	366C66	CDR-C66	
366Q96	TKFIST HQ	Add'l ModSAF	366Q95	TKFIST HQ	ModSAF
366D70	FSG-D70	Add'l ModSAF	366C70	FSG-C70	ModSAF
1/D/3-66 AR			1/C/3-66 AR		
366D11	PL-1D-D11	Role-Played	366C11	PL-1C-C11	
366D12	WM1-1D-D12		366C12	WM1-1C-C12	
366D13	WM2-1D-D13		366C13	WM2-1C-C13	
366D14	PS-1D-D14		366C14	PS-1C-C14	
3/D/3-66 AR			3/C/3-66 AR		
366D31	PL-3D-D31	Role-Played	366C31	PL-3C-C31	
366D32	WM1-3D-D32		366C32	WM1-3C-C32	
366D33	WM2-3D-D33		366C33	WM2-3C-C33	
366D34	PS-3D-D34		366C34	PS-3C-C34	
3/B/1-22 IN			2/D/1 IN		
122B31	PL-3B-B31	Role-Played	122D21	PL-3D-D21	
122B32	WM1-3B-B32		122D22	WM1-3D-D22	
122B33	WM2-3B-B33		122D23	WM2-3D-D23	
122B34	PS-3B-B34		122D24	PS-3D-D24	
TM B/1-22 MECH BN (1-22AS)			**TM D/1-22 MECH BN (1-22AS)**		
BUMPER #	**ROLE**	**NOTES**	**BUMPER #**	**ROLE**	**NOTES**
Company Elements			Company Elements		
122B65	XO-B65		122D65	XO-D66	
122B66	CDR-B66		122D66	CDR-D66	
122Q74	INFIST HQ	Add'l ModSAF	122Q76	INFIST HQ	ModSAF
122B67	FSG-B67	Add'l ModSAF	122D67	FSG-D67	ModSAF
1/B/1-22 IN			1/D/1-22 IN		
122B11	PL-1B-B11		122D11	PL-1D-D11	
122B12	WM1-1B-B12		122D12	WM1-1D-D12	
122B13	WM2-2B-B13		122D13	WM2-1D-D13	
122B14	PS-1B-B14		122D14	PS-1D-D14	
2/B/1-22 IN			3/D/1-22 IN		
122B21	PL-2B-B21		122D31	PL-3D-D31	
122B22	WM1-2B-B22		122D32	WM1-1D-D12	
122B23	WM2-2B-B23		122D33	WM2-1D-D13	
122B24	PS-2B-B24		122D34	PS-1D-D14	
2/D/3-66 AR			2/C/3-66 AR		
366D21	PL-2D-D21		366C21	PL-2C-C21	
366D22	WM1-2D-D22		366C22	WM1-2C-C22	
366D23	WM2-2D-D23		366C23	WM2-2C-C23	
366D24	PS-2D-D24		366C24	PS-2C-C24	

Table 3-2 Task Organization and Bumper Numbers

3.5.2 Entity Identifications and Associated Enumerations

The entity identifications and associated enumerations are given in Table 3-3.

Item #	Entity Name	DIS 2.03 Enum	Vis Mod	Ft. Knox verified	Ft. Rucker verified
BLUFOR					
1	M1A2	1.1.225.1.1.2.0	M1A1		
2	M3A2	1.1.225.2.4.0.0	M2A2		
3	M977 (Cargo)	1.1.225.7.2.0.0	M977		
4	M978 (Fuel Resupply)	1.1.225.7.3.0.0	M978		
5	M120 (Mortar) (M106A1)	1.1.225.2.9.0.0	M106/119		
6	HMMWV	1.1.225.6.1.0.0	NLOS		
7	AH-64A	1.2.225.6.1.0.0	AH-64A		
8	M35A2_FDC	1.1.225.7.7.0.0	M577		
9	AGM 114A (Hellfire LASER)	2.2.225.1.3.0.0			
10	AGM 114A (Hellfire RF)	2.2.225.1.8.0.0			
11	M789 (30 mm Chaingun)	2.9.225.2.3.0.0			
12	M240 7.62 mm MG (M1A2/M3A3)	2.9.225.2.19.4.0.5000			
13	M792 25 mm HE (M3A3)	2.2.225.2.1.0.0.1200			
14	M829A2 120 mm KE (M1A2)	2.2.225.2.13.2.0.5000			
15	M830A1 120 mm HEAT (M1A2)	2.2.225.2.13.3.0.1600			
16	M933_934 120 mm HE (M120)	2.9.225.2.11.0.0.1500			
17	TOW (M3A3)	2.2.225.1.1.0.0.1600			
18	M919 25 mm APFSDS-T (M3A3)	2.2.225.2.3.3.0.1000			
OPFOR					
19	T-80 Tank	1.1.222.1.1.0.0	T-72		
20	BMP-2	1.1.222.2.2.0.0	BMP-2		
21	ZSU23_4M	1.1.222.4.18.0.0	2S6		
22	BTR-80	1.1.222.2.13.0.0	BTR-80		
23	SA-6 (Missile)	1.1.222.4.19.0.0	2S6		
24	2S6	1.1.222.4.22.0.0	2S6		
25	M125 HEAT (T80)	2.2.222.2.7.0.0.1600			
26	M125 SABOT (T80)	2.2.222.2.7.0.0.5000			
27	145 mm MG (BTR-80)	2.8.222.2.4.0.0.5000			
28	30 mm HE (BMP-2)	2.2.222.2.2.2.1.1000			
29	30 mm SABOT (BMP-2)	2.2.222.2.2.2.1.5000			
30	SONGSTER (T80)	2.2.222.1.10.0.0.1600			
31	SPANDREL (BMP-2)	2.2.222.1.7.0.0.1600			
32	30 mm HE (2S6)	2.2.222.2.2.3.2.1000			
33	SA-19 (2S6)	2.1.222.1.26.0.0.1000			
34	SA-6 (SA6)	2.1.222.1.17.0.0.1000			
35	7.62 mm (BTR-80)	2.8.222.2.2.2.0.5000			
36	23AP (ZSU-23)	2.2.222.2.1.0.0.5000			

Table 3-3 GPS DIS Enumerations

4. Conduct of The Experiment

4.1 Schedules and Experiment Execution

The GPS DIS experiment was conducted in accordance with the schedule depicted in Figure 4-1. As can be seen from the schedule, time was allotted for simultaneous local site

simulation equipment integration followed by Long Haul Test (LHT) number 1 which tested connectivity, visual database correlation, entity identification, and radio communications. After LHT Number 1, the SA Server and CIGNM were then integrated and tested in LHT number 2. At this point, the system was ready for pilot training and test which started on October 27, 1997 and culminated in a full dry run exercise (LHT number 3) on October 31, 1997. The training provided familiarization and orientation on the actual operation of the simulators and Appliqué's. During the Pilot Test the simulator operators and other experiment support personnel used the skills acquired in Troop Training to conduct tactical operations in a scenario to stress the systems and the operators' skills. The Test Readiness Review was held in a series of telephone conversations from October 31 through November 2, the conclusion of these conversations was that the system was ready for the experiment to begin as originally scheduled on November 3, 1997. The experiment commenced on Monday November 3 and concluded successfully on Tuesday November 18, 1997. Excursion runs were performed from Wednesday November 19 through Friday November 21. The experiment completed 48 different iterations plus excursion runs, and were executed using six different overlays in both day and night exercises. The scenario trial activities were Baseline, No Jam, Medium Jam, and High Jam of the Appliqués/GPS.

The four manned M1A2 simulators were configured as a Platoon within a Blue Armor Company. The remainder of the Company included two additional tank platoons of Blue ModSAF and a Company Commander and Executive Officer role-playing from a ModSAF workstation. The Blue Force (BLUFOR) conducted tactical operations against an appropriate doctrinally approved and depicted Opposing Force (OPFOR) ModSAF threat. An Experiment Director was provided by SES Inc. to support the experiment. The daily schedule for the experiment is contained in Appendix D.

Task Name	Start	Finish
Contract Award	9/11/97	3/12/98
MWTB Integration	10/6/97	10/23/97
Integrate Local Equip.	10/6/97	10/10/97
Integrate CIGNM Model (CSC)	10/20/97	10/23/97
Integrate SA Server (MITRE)	10/20/97	10/23/97
MWTB Local Test	10/23/97	10/23/97
AVTB Integration	10/6/97	10/23/97
Integrate Local Equip.	10/6/97	10/10/97
Integrate CIGNM Model (CSC)	10/20/97	10/23/97
Integrate SA Server (MITRE)	10/20/97	10/23/97
AVTB Local Test	10/23/97	10/23/97
GFI Scenarios Provided	10/13/97	10/13/97
Long Haul Network (LHN) Test #1	10/13/97	10/17/97
Long Haul Network (LHN) Test #2	10/23/97	10/24/97
Applique' Training	10/27/97	10/29/97
Pilot Tests and LHN Test #3	10/30/97	10/31/97
Data Collection Prep	10/20/97	11/2/97
Test Readiness Review	10/31/97	11/2/97
Experiment Execution	11/3/97	11/21/97
Site Reconfiguration	11/22/97	12/1/97
Data Reduction (AB01) & Submit	11/23/97	1/6/98
AB01 Gov't Review & Comment	1/6/98	2/4/98
AB01 Incorporate Gov't Comments	2/4/98	2/13/98
Generate Final Report (AB02) & Submit	11/23/97	1/31/98
AB02 Gov't Review & Comment	2/1/98	3/2/98
AB02 Incorporate Gov't Comments	3/3/98	3/12/98

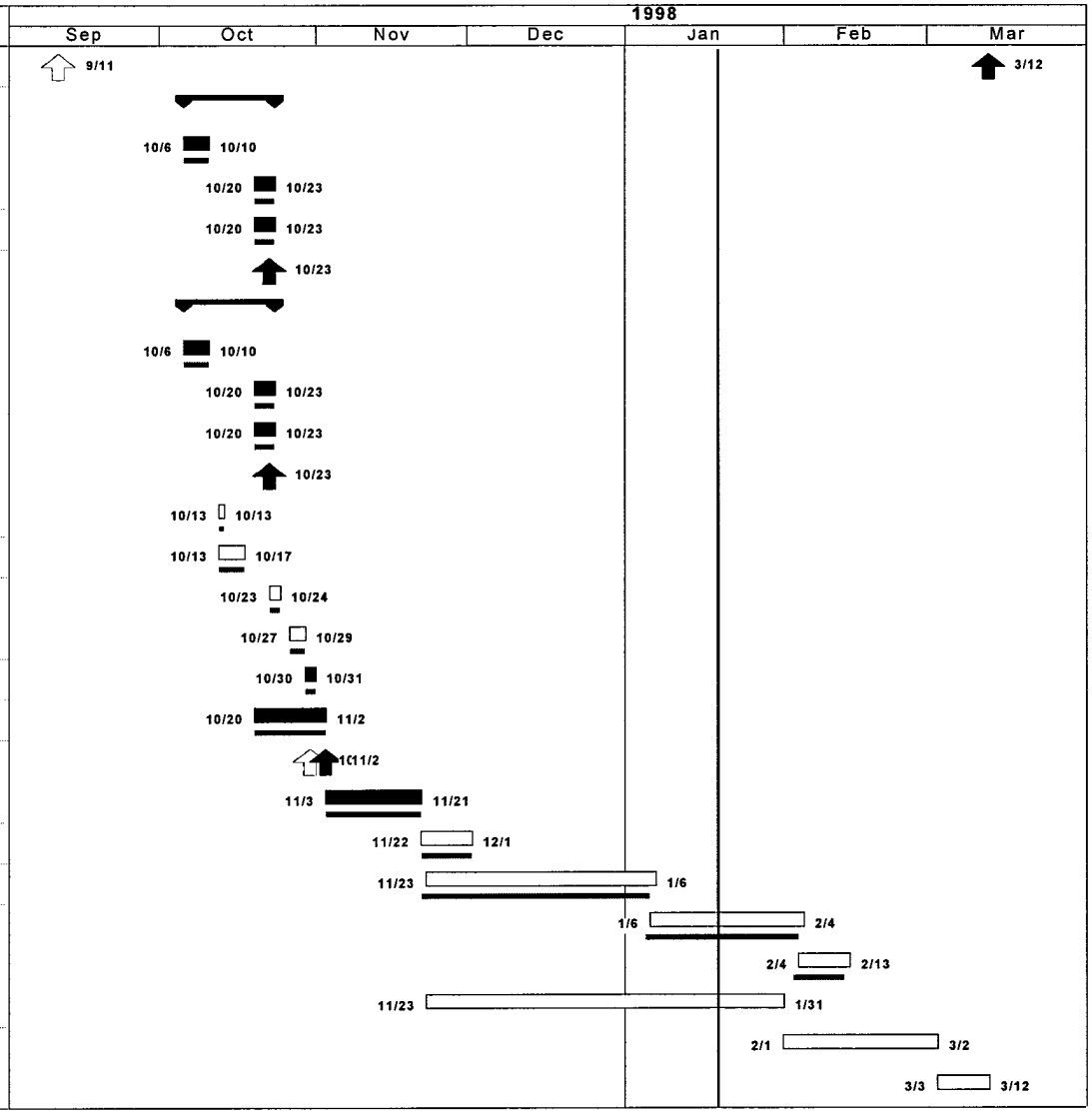

Figure 4-1 GPS DIS Master Schedule

5. Observations and Lessons Learned

5.1 Development and Integration

- Observation #1

Inadequate time permitted for informal integration and test of newly developed software (prior to beginning of experiment).

- Discussion #1

The CIGNM and SA Server GFE/I hardware and software had never been integrated with the site equipment suite (or even a similar suite) prior to formal site integration. There were several integration problems that required significant overtime by several contractors to resolve. This problem increased program cost, risk, and could have seriously impacted the schedule.

- Lesson Learned #1

Need to allow adequate informal integration and test time for new/modified software/hardware in the program schedule prior to formal integration.

- Observation #2

New GFI software not completed and tested at beginning of the formal integration period.

- Discussion #2

The CIGNM and SA Server GFE/I hardware and software was not completely finished and tested at the beginning of the formal integration period. This delayed Long Haul integration and test, increased program risk, required significant overtime by several contractors (thereby increasing program cost), and also had the potential to greatly impact the Master Schedule.

- Lesson Learned #2

Need to allow adequate time in the program schedule to completely finish and test all new and modified software.

- Observation #3

Inadequate real time situational awareness/communication between Long Haul sites during integration and troubleshooting.

- Discussion #3

While troubleshooting the system during long haul integration and also during the experiment, a constantly open, speaker-type telephone was used for communication between the engineers at the sites.

This proved to be constraining and cumbersome as it was necessary to return to the telephone each time we needed to speak with the engineers at the other site. This resulted in reduced efficiency thereby causing delay in problem resolution and consequently increased cost to the program.

- Lesson Learned #3

Some sort of wireless, personal, portable, headset type communication that provides full duplex, multi-party long distance telephone capability for all site engineers should be investigated and implemented on all future long haul experiments.

- Observation #4

Inadequate Dial-A-Tank memory

- Discussion #4

It was discovered during preparation for the experiment that the memory in the Dial-A-Tank computers (3) was not large enough to accommodate the NTC visual database (limitation of the configuration of the computers). This required generating 3 small databases for the experiment (each a collection of NTC Database segments) and loading the appropriate one of these small databases on each of the three Dial-A-Tank computers before each exercise. This loading process was automated and was easily loaded by the Dial-A-Tank resupply role player before each exercise. It was also necessary to generate 5 additional small databases for the excursion runs; these were loaded in the same manner as the databases for the experiment. This computer limitation and subsequent resolution did not adversely affect the experiment but did require additional unplanned time to investigate and resolve and could have potentially impacted the Master Schedule.

- Lesson Learned #4

This problem would have been discovered and mitigated earlier had there been adequate experiment planning time.

5.2 Experiment

- Observation #1

Throughout the 3 long haul Network integration periods, the Defense Simulation Internet (DSI) Long Haul Network was extremely unreliable.

- Discussion #1

The DSI service is in the process of transitioning from Houston Associates to the Defense Information Systems Agency (DISA). It was planned that Houston Associates would "shadow" DISA during the transition, but there seemed to be a great lack of communication between them as well as exchange of incorrect information between them.

The problems with the DSI caused the GPS DIS Program several significant delays resulting in great expense and program delays. The network went down several times each day during integration for various reasons. The following is a list of some of the causes:

a) Necessity of repeatedly resetting the classified Improved Network Encryption System (INES), Aggregators, and long haul site routers.

b) Wrong date set in the long haul site routers.

c) Wrong router configuration at network control points (change with no apparent reason).

d) Some part or all of the network was seemingly arbitrarily taken down for maintenance and test without notice.

e) Key disk taken out of master network INES by Houston Associates in Arlington for no apparent reason.

f) DISA took the master INES down for maintenance while we were trying to get the network up to prepare for the experiment 2 days before scheduled start of long haul portion of the experiment.

g) Many instances where the reason was never found.

GPS DIS was a classified experiment, thus necessitating the use of the INES encryption device. This device requires a key and a software disk that is provided by DSI via Post Security. There were several occasions where the disk provided by DISA/Houston Associates did not work. This caused great delay because this was always the last thing that by DISA/Houston Associates suspected as being wrong. Also, Ft. Rucker has a 2 man policy for transporting the disk which caused delays waiting until Post Security could provide the required 2 men. There were many instances where the full crew at both sites (45 people minimum) just simply waited for the long haul to become operational during integration.

Just prior to the start of the experiment and at a point where the DSI was not operating reliably, it became known that the actual central office transition was made from Houston Associates equipment in Arlington, VA to DISA equipment in Columbus, Ohio.

This was done without any notice to anyone on the GPS DIS program, causing a great waste of time for a full crew at both sites on overtime (Saturday). Note that time wasted included site engineers looking for problems local to the sites, when all the time the problem causing the long haul to not be operational was in the long haul network. During this time, all the simulator, role player, and support personnel were waiting for the system to become operational. When the central office change became known, and the network was still down, STRICOM and Lockheed-Martin required DISA and Houston Associates Management to get involved to make the link reliably operational. Additionally, when it attained that state, they were required to make the DSI available to the GPS DIS Program 24 hours a day 7 days a week until experiment conclusion. They were also requested to place "DO NOT TOUCH" signs on all terminals and control points in the network that control the GPS DIS network, to prevent personnel from changing key network parameters and taking equipment down without notice (which causes the network to go down).

These things occurred particularly at the beginning of DSI and Houston Associates shift changes and on weekends. After DSI and Houston Associates Management became involved, the network was operational within 24 hours and was acceptably reliable (went down for a very short period 3 times) through the end of the experiment.

- Lesson Learned #1

Consideration should be given to alternate long haul services, but if the DSI must be used (it should be noted here that the cost for the use of the DSI is not presently an expense to the using program, but rather to STRICOM), the following suggestions should be considered:

a) Contact key DISA and Houston Associates management prior to start of integration and experiment and status with them regularly throughout these periods.

b) Require 24 hour, 7 day uninterrupted service throughout all integration and experiment periods.

c) Attempt connectivity between sites at least one week prior to the need date (to ensure key availability, etc.).

d) Ensure proper long haul network operation at least one hour before need time each day.

e) Require proper safeguards on all net control points throughout the network to prevent unauthorized change of network parameters.

- Observation #2

MWTB M1A2 Manned Simulators operation not reliable.

- Discussion #2

Throughout the 3 integration periods and the entire experiment, none of the 4 M1A2 manned simulators was operational for more than one and one half hours. When a simulator went

down, sometimes it could be restarted and continue in the exercise, but most of the time it could not be used for the rest of that exercise.

This operational limitation adversely affected the exercise in terms of force capability and therefore had a negative impact on the data collected. This problem also impacted the experiment schedule on the occasions that the exercise started a significant amount of time after the simulators were started, thus requiring the simulators to be restarted which requires a long startup sequence. This issue impacts on scenario development, exercise duration, time spent on the simulators during integration and testing, and the length of the schedule required to accomplish the experiment.

The experiment scenarios were designed with this time limitation as a consideration, and most exercises ended just prior to problems occurring. To prevent problems from appearing in successive runs, a lengthy reboot effort took place between each run causing a great deal of time to be wasted thus creating additional cost to the program. The simulator systems need to be more reliable in order to decrease the time to conduct an experiment thereby saving cost. Note that the FPE III experiment made these same observations.

- Lesson Learned #2

Although resources have been allocated through the CDF Upgrades Delivery Order to upgrade and improve the reliability of the simulators, these upgrades may not fully correct the problem. This is a serious issue which needs to be addressed as soon as possible if the currently underway CDF Upgrades work does not correct the situation.

- Observation #3

New GFI developed software exceptions not well handled.

- Discussion #3

There were several instances where various other system entities' Emissions PDUs (i.e. Anti-Aircraft weapons, etc.) caused the SA Server and CIGNM to crash. These problems were caused by very terse PDU data field checking without appropriate exception handling, and also by improper handling of variable data length PDUs. These problems were fixed by patching the SA Server and CIGNM software to handle these DIS compliant PDUs.

These problems increased program risk and impacted the Master Schedule, requiring significant overtime. This increased program costs considerably.

- Lesson Learned #3

Adequate informal integration time prior to formal integration probably would have alleviated this problem. Also, adequate time for ADST II System Engineers to work with the software development contractors prior to formal integration may have alleviated this problem.

- Observation #4

Problem areas in Manned Simulator Visual Database

- Discussion #4

There were several instances where the manned simulator tanks would find themselves actually below the surface of the ground (from a few to thousands of meters) and then would be unable to move. In some cases, the tank could be "teleported" a hundred meters or so forward and would be able to continue in the exercise, but more often would be unable to continue. When the simulator was unable to continue, the experiment was adversely affected in terms of force capability, and therefore had a negative impact on the data collected. This problem increased program risk and impacted the Master Schedule. There were also cases where a tank would be "killed" and then observed by other tanks to fly through the air. Although bizarre to see, the "flying tank" episodes did not adversely impact the experiment (or the data); it was merely a nuisance, but was obviously improper in a professional simulation environment.

- Lesson Learned #4

It was determined that this was not a simple problem to resolve, and that it would not be possible to correct this problem during the experiment. This problem was not known at the beginning of the experiment, and therefore was not considered in the budget. In any event, since the problem was not known and therefore not scheduled for resolution, manpower of the correct skill mix was not available during the experiment to address this problem.

- Observation #4

The CIGNM model did not operate correctly with Network ESPDUs upon initial formal integration.

- Discussion #4

The CIGNM contains a model that includes the positioning of the GPS satellites and their relative position to all entities. An entity can move a significant distance from the time it issues an ESPDU (which provides the entity's location, time-stamped to its own simulator's clock) and the time the ESPDU is received by the CIGNM. Because of these factors, the network ESPDU latency time became a significant problem for the CIGNM. Note that the clocks in the various simulators/simulations creating the network entities are not synchronized. This latency meant that the entities' position was actually different when it was received by the CIGNM than when the entity originally issued the ESPDU. This problem was resolved by adding software to the CIGNM that time-tagged the ESPDUs to the

time of the CIGNM system clock, and by synchronizing the CIGNM system clock to the SA Server system clock.

- Lesson Learned #4

CSC personnel stated that one of the design guidelines of the CIGNM model was that the time stamp contained in all entity ESPDUs was "valid upon receipt" by the receiving entity (CIGNM). The meaning of this phrase is apparently interpretive without a full understanding of the DIS protocol. There was no informal integration period and as a consequence, this problem was not discovered until the formal integration period. This problem required unplanned time for investigation, running a series of ESPDU network propagation tests, and writing additional software during the formal integration period. This required significant contractor and site personnel overtime, thus increasing program costs. An appropriate informal integration period of the CIGNM with the site simulation equipment suite would have precluded this problem.

5.3 Overall

- Observation #1

Inadequate time allotted for experiment planning and preparation.

- Discussion #1

Several of the lessons learned above strongly indicate that adequate time was not allowed for the planning and preparation phases of the GPS DIS experiment. This issue had several negative impacts on the program, the more prominent ones are listed above. Although the experiment was a complete success, the lack of time for planning created the necessity for a great deal of overtime which added greatly to the risk and expense of the program.

- Lesson Learned #1

Significantly more time needs to be allocated in the overall schedule for experiment planning and preparation.

6. Conclusion

The GPS DIS experiment was a fast paced and technically complex effort that achieved its goal. The existing ADST II simulation equipment and successful integration of the GFE/I software models into the MWTB and AVTB provided the desired synthetic environment for the customer. This environment allowed the customer to collect data that will be used to analyze and offset the effects of GPS jamming. This data will also ultimately help to better preserve the force in combat operations.

7. Points of Contact

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APPENDIX A
Acronym List

AAR	After Action Review
ADST	Advanced Distributed Simulation Technology
AH	Attack Helicopter
AVTB	AViation Test Bed
BFV	Bradley Fighting Vehicle
BLEP	Battle Lab Experiment Plan
BLUFOR	Blue Forces
C2	Command and Control
C2SID	Command and Control Systems Integration Directorate
C2TD	Command and Control Tactical Display
CDF	Core DIS Facility
CDRL	Contract Data Requirements List
CECOM	Communications & Electronics Command
CIG	Computer Image Generator
CIGNM	CECOM Integrated GPS Navigation Model
DIS	Distributed Interactive Simulation
DISA	Defense Information Systems Agency
DO	Delivery Order
DSI	Defense Simulation Internet
DTLOMS	Doctrine, Training, Leaders, Organization, Material, and Soldiers
EPLRS	Enhanced Position Location Reporting System
ESPDU	Entity State Protocol Data Unit
FRAGO	Fragmentary Order
FTP	File Transfer Protocol
GFE	Government Furnished Equipment

GFI	Government Furnished Information
GPS	Global Positioning System
H/W	Hardware
INC	INternet Controller
INES	Improved Network Encryption System
I/O	Input/Output
LAN	Local Area Network
LHT	Long Haul Test
LMC	Lockheed Martin Corporation
LMSG	Lockheed Martin Service Group
M1Ax	Abrams Main Battle Tank (x signifies variant)
MBT	Main Battle Tank
MMBL	Mounted Maneuver Battle Lab
ModSAF	Modular Semi-Automated Forces
MPDD	Multi-Purpose Digital Display
MWTB	Mounted Warfare Test Bed
NAVWAR	NAVigation WARfare
OC	Observer Controller
OPFOR	Opposing Forces
OPORD	Operations Order
OS	Operating System
OSF	Operational Support Facility
PC	Personnel Computer
PDU	Protocol Data Unit
PK	Probability of Kill
PLGR	Precision Lightweight GPS Receiver
PM	Program Manager
POC	Point of Contact

PPP	Point-To-Point Protocol
PVD	Plan View Display
RAM	Random Access Memory
RF	Radio Frequency
RIU	Radio Interface Unit
RP	Role Player
RWA	Rotary Wing Aircraft
SAF	Semi-Automated Forces
SAIC	Science Applications International Corporation
SEIT	Systems Engineering Integration Team
SGI	Silicon Graphics Industries
SIMNET	Simulation Network
SINCGARS	Single Channel Ground and Airborne Radio System
SME	Subject Matter Expert
SOW	Statement of Work
SRE	SINCGARS Radio Emulator
SRM	SINCGARS Radio Model
STRICOM	Simulation Training and Instrumentation Command (US Army)
TC	Tank Commander
TF	Task Force
TIM	Tactical Internet Model
TIM	Technical Interchange Meeting
TRR	Test Readiness Review
TTP	Tactics, Techniques, and Procedures
UDP	User Data Protocol
VDD	Version Description Document
VMF	Variable Message Format
VIP	Very Important Person

APPENDIX B

GPS DIS Daily Schedule

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Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
Monday 3 Nov 97							
	1	Daily Data Collection Pre-			800	n/a	MWTB
	2	Daily Exercise			830	n/a	MWTB
	3	Run #1 Baseline	1	Night	900	n/a	MWTB
	4	Debrief/reset/Brief			1030	n/a	MWTB
	5	Run #2 Baseline	3	Night	1100	n/a	MWTB
	6	Debrief/Reset/Brie			1230	n/a	MWTB
	7	Lunch			1300	n/a	MWTB
	8	Run #3 Baseline	5	Night	1330	n/a	MWTB
	9	Debrief/reset/Brief			1500	n/a	MWTB
	10	Run #4 Appliqué No Jam	2	Night	1530	n/a	MWTB
	11	Exercise Debrief/ End of day status			1700	n/a	MWTB
	12	Data Collection De-Brief			1730	n/a	MWTB
	13	Shutdown			1800	n/a	MWTB
Tuesday 4 Nov 97							
	14	Daily Data Collection Pre-			800	n/a	MWTB
	15	Daily Exercise			830	n/a	MWTB
	16	Run #5 Appliqué No Jam	3	Night	900	n/a	MWTB
	17	Debrief/reset/Brief			1030	n/a	MWTB
	18	Run #6 Appliqué No Jam	5	Night	1100	n/a	MWTB
	19	Debrief/reset/Brief			1230	n/a	MWTB
	20	Lunch			1300	n/a	MWTB
	21	Run #7 Baseline	4	Night	1330	n/a	MWTB
	22	Debrief/reset/Brief			1500	n/a	MWTB
	23	Run #8 Baseline	6	Night	1530	n/a	MWTB
	24	Exercise Debrief/ End of day status			1700	n/a	MWTB
	25	Data Collection De-Brief			1730	n/a	MWTB
	26	Shutdown			1800	n/a	MWTB
Wednesday 5 Nov 97							

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
	27	Daily Data Collection Pre-			800	n/a	MWTB
	28	Daily Exercise			830	n/a	MWTB
	29	Run #9 Baseline	2	Night	900	n/a	MWTB
	30	Debrief/reset/Brief			1030	n/a	MWTB
	31	Run #10 Appliqué No Jam	4	Night	1100	n/a	MWTB
	32	Debrief/reset/Brief			1230	n/a	MWTB
	33	Lunch			1300	n/a	MWTB
	34	Run #11 Appliqué No Jam	6	Night	1330	n/a	MWTB
	35	Debrief/reset/Brief			1500	n/a	MWTB
	36	Run #12 Appliqué No Jam	1	Night	1530	n/a	MWTB
	37	Exercise Debrief/ End of day status			1700	n/a	MWTB
	38	Data Collection De-Brief			1730	n/a	MWTB
	39	Shutdown			1800	n/a	MWTB
Thursday 6 Nov 97							
	40	Daily Data Collection Pre-			800	n/a	MWTB
	41	Daily Exercise			830	n/a	MWTB
	42	Run #13 Appliqué Med Jam	3	Night	900	n/a	MWTB
	43	Debrief/reset/Brief			1030	n/a	MWTB
	44	Run #14 Appliqué Med Jam	5	Night	1100	n/a	MWTB
	45	Debrief/reset/Brief			1230	n/a	MWTB
	46	Lunch			1300	n/a	MWTB
	47	Run #15 Appliqué Med Jam	1	Night	1330	n/a	MWTB
	48	Debrief/reset/Brief			1500	n/a	MWTB
	49	Run #16 Appliqué High Jam	2	Night	1530	n/a	MWTB
	50	Exercise Debrief/ End of day status			1700	n/a	MWTB
	51	Data Collection De-Brief			1730	n/a	MWTB
	52	Shutdown			1800	n/a	MWTB
Friday 7 Nov 97							
	53	Daily Data Collection Pre-			800	n/a	MWTB
	54	Daily			830	n/a	MWTB

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
	55	Run #17 Appliqué High Jam	3	Night	900	n/a	MWTB
	56	Debrief/reset/Brief			1030	n/a	MWTB
	57	Run #18 Appliqué High Jam	5	Night	1100	n/a	MWTB
	58	Debrief/reset/Brief			1230	n/a	MWTB
	59	Lunch			1300	n/a	MWTB
	60	Run #19 Appliqué Med Jam	4	Night	1330	n/a	MWTB
	61	Debrief/reset/Brief			1500	n/a	MWTB
	62	Run #20 Appliqué Med Jam	6	Night	1530	n/a	MWTB
	63	Exercise Debrief/ End of day status			1700	n/a	MWTB
	64	Data Collection De-Brief			1730	n/a	MWTB
	65	Shutdown			1800	n/a	MWTB
Monday 10 Nov 97							
	66	Contact DISA, Ensure LHN Is UP			730	630	MWTB AVTB
	67	Daily Data Collection Pre-			800	700	MWTB AVTB
	68	Daily Exercise Pre-Brief			830	730	MWTB AVTB
	69	Run #21 Baseline	1	Day	900	800	MWTB AVTB
	70	Debrief/reset/Brief			1030	930	MWTB AVTB
	71	Run #22 Baseline	3	Day	1100	1000	MWTB AVTB
	72	Debrief/reset/Brief			1230	1130	MWTB AVTB
	73	Lunch			1300	1200	MWTB AVTB
	74	Run #23 Baseline	5	Day	1330	1230	MWTB AVTB
	75	Debrief/reset/Brief			1500	1400	MWTB AVTB
	76	Run #24 Appliqué No Jam	2	Day	1530	1430	MWTB AVTB
	77	Exercise Debrief/ End of day status			1700	1600	MWTB AVTB
	78	Data Collection De-Brief			1730	1630	MWTB AVTB

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
	79	Shutdown			1800	1700	MWTB AVTB
Tuesday 11 Nov 97							
	80	Contact DISA, Ensure LHN Is UP			730	630	MWTB AVTB
	81	Daily Data Collection Pre-			800	700	MWTB AVTB
	82	Daily Exercise Pre-Brief			830	730	MWTB AVTB
	83	Run #25 Appliqué No Jam	3	Day	900	800	MWTB AVTB
	84	Debrief/reset/Brief			1030	930	MWTB AVTB
	85	Run #26 Appliqué No Jam	5	Day	1100	1000	MWTB AVTB
	86	Debrief/reset/Brief			1230	1130	MWTB AVTB
	87	Lunch			1300	1200	MWTB AVTB
	88	Run #27 Appliqué Med Jam	4	Day	1330	1230	MWTB AVTB
	89	Debrief/reset/Brief			1500	1400	MWTB AVTB
	90	Run #28 Appliqué Med Jam	6	Day	1530	1430	MWTB AVTB
	91	Exercise Debrief/ End of day status			1700	1600	MWTB AVTB
	92	Data Collection De-Brief			1730	1630	MWTB AVTB
	93	Shutdown			1800	1700	MWTB AVTB
Wednesday 12 Nov 97							
	94	Contact DISA, Ensure LHN Is UP			700	600	MWTB AVTB
	95	Daily Data Collection And Exercise			730	630	MWTB AVTB
	96	Item Deleted					
	97	Run #29 Appliqué Med Jam	2	Day	800	700	MWTB AVTB

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
	98	Debrief/reset/Brief			930	830	MWTB AVTB
	99	Run #30 Appliqué High Jam	1	Day	1000	900	MWTB AVTB
	100	Debrief/reset/Brief			1130	1030	MWTB AVTB
	101	Lunch			1200	1100	MWTB AVTB
	102	Run #31 Appliqué High Jam	3	Day	1230	1130	MWTB AVTB
	103	Debrief/reset/Brief			1400	1300	MWTB AVTB
	104	Run #32 AppliquéHigh Jam	5	Day	1430	1330	MWTB AVTB
	105	Exercise And Data Collection Debrief /End			1600	1500	MWTB AVTB
	106	Over Run/ ReRun			1630	1530	MWTB AVTB
	107	Shutdown			1730	1630	MWTB AVTB
Thursday 13 Nov 97							
	108	Contact DISA, Ensure LHN Is UP			700	600	MWTB AVTB
	109	Daily Data Collection And Exercise			730	630	MWTB AVTB
	110	Item Deleted					
	111	Run #33 Baseline	2	Day	800	700	MWTB AVTB
	112	Debrief/reset/Brief			930	830	MWTB AVTB
	113	Run #34 Baseline	4	Day	1000	900	MWTB AVTB
	114	Debrief/reset/Brief			1130	1030	MWTB AVTB
	115	Lunch			1200	1100	MWTB AVTB
	116	Run #35 Baseline	6	Day	1230	1130	MWTB AVTB
	117	Debrief/reset/Brief			1400	1300	MWTB AVTB
	118	Run #36 Appliqué No Jam	1	Day	1430	1330	MWTB AVTB

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
	119	Exercise And Data Collection Debrief /End			1600	1500	MWTB AVTB
	120	Over Run/ ReRun			1630	1530	MWTB AVTB
	121	Shutdown			1730	1630	MWTB AVTB
Friday 14 Nov 97							
	122	Contact DISA, Ensure LHN Is UP			700	600	MWTB AVTB
	123	Daily Data Collection And Exercise			730	630	MWTB AVTB
	124	Item Deleted					
	125	Run #37 Appliqué No Jam	4	Day	800	700	MWTB AVTB
	126	Debrief/reset/Brief			930	830	MWTB AVTB
	127	Run #38 Appliqué No Jam	6	Day	1000	900	MWTB AVTB
	128	Debrief/reset/Brief			1130	1030	MWTB AVTB
	129	Lunch			1200	1100	MWTB AVTB
	130	Run #39 Appliqué Med Jam	1	Day	1230	1130	MWTB AVTB
	131	Debrief/reset/Brief			1400	1300	MWTB AVTB
	132	Run #40 Appliqué Med Jam	3	Day	1430	1330	MWTB AVTB
	133	Exercise And Data Collection Debrief /End			1600	1500	MWTB AVTB
	134	Over Run/ ReRun			1630	1530	MWTB AVTB
	135	Shutdown			1730	1630	MWTB AVTB
Saturday 15 Nov 97							
	136	Contact DISA, Ensure LHN Is UP			700	600	MWTB AVTB
	137	Daily Data Collection And Exercise			730	630	MWTB AVTB
	138	Item Deleted					

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
	139	Run #41 Appliqué Med Jam	5	Day	800	700	MWTB AVTB
	140	Debrief/reset/Brief			930	830	MWTB AVTB
	141	Run #42 Appliqué High Jam	2	Day	1000	900	MWTB AVTB
	142	Debrief/reset/Brief			1130	1030	MWTB AVTB
	143	Lunch			1200	1100	MWTB AVTB
	144	Run #43 Appliqué High Jam	4	Day	1230	1130	MWTB AVTB
	145	Debrief/reset/Brief			1400	1300	MWTB AVTB
	146	Run #44 Appliqué High Jam	6	Day	1430	1330	MWTB AVTB
	147	Exercise And Data Collection Debrief /End			1600	1500	MWTB AVTB
	148	Over Run/ ReRun			1630	1530	MWTB AVTB
	149	Shutdown			1730	1630	MWTB AVTB
Sunday 16 Nov 97							
	150	Contact DISA, Ensure LHN Is UP			700	600	MWTB AVTB
	151	Daily Data Collection And Exercise			730	630	MWTB AVTB
	152	Item Deleted					
	153	Over Run/ ReRun		Day	800	700	MWTB AVTB
	154	Debrief/reset/Brief			930	830	MWTB AVTB
	155	Over Run/ ReRun		Day	1000	900	MWTB AVTB
	156	Debrief/reset/Brief			1130	1030	MWTB AVTB
	157	Lunch			1200	1100	MWTB AVTB
	158	Over Run/ ReRun		Day	1230	1130	MWTB AVTB
	159	Debrief/reset/Brief			1400	1300	MWTB AVTB

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
	160	Over Run/ ReRun		Day	1430	1330	MWTB AVTB
	161	Exercise And Data Collection Debrief /End			1600	1500	MWTB AVTB
	162	Over Run/ ReRun			1630	1530	MWTB AVTB
	163	Shutdown			1730	1630	MWTB AVTB
Monday 17 Nov 97							
	164	Daily Data Collection And Exercise			730	n/a	MWTB
	165	Item Deleted					
	166	Run #45 Baseline	2	Night	800	n/a	MWTB
	167	Debrief/reset/Brief			930	n/a	MWTB
	168	Run #46 Appliqué High Jam	3	Night	1000	n/a	MWTB
	169	Debrief/reset/Brief			1130	n/a	MWTB
	170	Lunch			1200	n/a	MWTB
	171	Run #47 Appliqué High Jam	5	Night	1230	n/a	MWTB
	172	Debrief/reset/Brief			1400	n/a	MWTB
	173	Run #48 Appliqué High Jam	1	Night	1430	n/a	MWTB
	174	Exercise And Data Collection Debrief /End			1600	n/a	MWTB
	175	Over Run/ ReRun			1630	n/a	MWTB
	176	Shutdown			1730	n/a	MWTB
Tuesday 18 Nov 97							
	177	Daily Data Collection And Exercise			730	n/a	MWTB
	178	Item Deleted					
	179	Over Run/ ReRun			800	n/a	MWTB
	180	Debrief/reset/Brief			930	n/a	MWTB
	181	Over Run/ ReRun			1000	n/a	MWTB
	182	Debrief/reset/Brief			1130	n/a	MWTB
	183	Lunch			1200	n/a	MWTB
	184	Over Run/ ReRun			1230	n/a	MWTB
	185	Debrief/reset/Brief			1400	n/a	MWTB
	186	Over Run/ ReRun			1430	n/a	MWTB

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
	187	Exercise And Data Collection Debrief /End			1600	n/a	MWTB
	188	Over Run/ ReRun			1630	n/a	MWTB
	189	Shutdown			1730	n/a	MWTB
Wednesday 19 Nov 97							
	190	Daily Data Collection And Exercise			730	n/a	MWTB
	191	Item Deleted					
	192	Excursion			800	n/a	MWTB
	193	Debrief/reset/Brief			930	n/a	MWTB
	194	Excursion			1000	n/a	MWTB
	195	Debrief/reset/Brief			1130	n/a	MWTB
	196	Lunch			1200	n/a	MWTB
	197	Excursion			1230	n/a	MWTB
	198	Debrief/reset/Brief			1400	n/a	MWTB
	199	Excursion			1430	n/a	MWTB
	200	Exercise And Data Collection Debrief /End			1600	n/a	MWTB
	201	Over Run/ ReRun			1630	n/a	MWTB
	202	Shutdown			1730	n/a	MWTB
Thursday 20 Nov 97							
	203	Daily Data Collection And Exercise			730	n/a	MWTB
	204	Item Deleted					
	205	Excursion			800	n/a	MWTB
	206	Debrief/reset/Brief			930	n/a	MWTB
	207	Excursion			1000	n/a	MWTB
	208	Debrief/reset/Brief			1130	n/a	MWTB
	209	Lunch			1200	n/a	MWTB
	210	Excursion			1230	n/a	MWTB
	211	Debrief/reset/Brief			1400	n/a	MWTB
	212	Excursion			1430	n/a	MWTB
	213	Exercise And Data Collection Debrief /End			1600	n/a	MWTB
	214	Over Run/ ReRun			1630	n/a	MWTB
	215	Shutdown			1730	n/a	MWTB

Date	Item	Activity	Overlay Number	Run Type	Ft. Knox Time	Ft. Rucker Time	Players
Friday 21 Nov 97							
	216	Daily Data Collection And Exercise			730	n/a	MWTB
	217	Item Deleted					
	218	Excursion			800	n/a	MWTB
	219	Debrief/reset/Brief			930	n/a	MWTB
	220	Excursion			1000	n/a	MWTB
	221	Debrief/reset/Brief			1130	n/a	MWTB
	222	Lunch			1200	n/a	MWTB
	223	Excursion			1230	n/a	MWTB
	224	Debrief/reset/Brief			1400	n/a	MWTB
	225	Excursion			1430	n/a	MWTB
	226	Exercise And Data Collection Debrief /End			1600	n/a	MWTB
	227	Over Run/ ReRun			1630	n/a	MWTB
	228	Shutdown			1730	n/a	MWTB